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# Co-operative Learning

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The social and intellectual outcomes  
of learning in groups

Edited by  
Robyn M. Gillies and  
Adrian F. Ashman

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## Co-operative learning in secondary education

### A curriculum perspective

Jan Terwel

#### Introduction

Co-operative learning has been championed by many advocates. One reason for its popularity lies in the flexibility of the term 'co-operative learning' and, consequently, in the possibility of applying it to different theories and educational contexts. At first sight this flexibility strikes one as positive, and no doubt it is. However, the term is potentially misleading if the conditions it denotes are not seen as being embedded in a particular theory, a specific domain of knowledge or a certain curricular context; for example, a common curriculum or a tracking system.

In co-operative learning contexts students do not learn in what may be called a compositional vacuum; they are members of a class and a small group. I will defend the claim that it is especially such compositional contexts that have consequences for learning opportunities in co-operative learning environments (Resh 1999; Terwel *et al.* 2001; Terwel and Van den Eeden 1994; Webb 1982).

Co-operative learning was designed and implemented to develop social strategies and acceptable social attitudes in students, and to improve social relations within and between groups. In addition, there is a large cluster of co-operative learning models aimed at cognitive development. Sometimes co-operative learning is directed at both the social and the cognitive side of human development.

There is yet a third, more comprehensive perspective, one that is not necessarily in contrast to the social and the cognitive aims of co-operative learning. I would like to call this the curriculum perspective on co-operative learning. This chapter is about that perspective.

If we take the curriculum perspective as a point of departure, then it follows that co-operative learning should be seen as a learning strategy in the mathematics curriculum, in particular, in the common curriculum of the first stage in secondary education. The consequences of this view will be explored in this chapter.

#### Co-operative learning from a curriculum perspective

But what is a curriculum? Walker (1990) described the curriculum in terms of content and purpose of an educational programme together with its organization.

#### Purpose

Placing co-operative learning in the context of curriculum theory and practice to me means that co-operative learning is not merely a many-purpose formal technique or model, but rather that it has to be viewed as an integrated part of the curriculum. The latter condition implies that co-operative learning should be evaluated from a curricular point of view. Let me therefore try first to formulate my curricular starting point by describing a general aim of co-operative learning, namely learning how to think for oneself (Dewey 1902, 1922, 1933). Independent thought is a fundamental human desideratum and, in my view, the educational goal for which schools should aim. Co-operative learning is one of the avenues that can lead to that fundamental goal, but only if correctly understood.

#### Content

The purposes and aims of co-operative learning need to be elaborated within certain domains of study. Co-operative learning is not a technique for its own sake but needs content in order to be useful. The specific content or subject matter is not a result of arbitrary choice, without any consequences for the design of a curriculum in which co-operative learning takes place. Content has its own characteristics, which may be used in the designing process and in the classroom in order to facilitate the development of thinking as a human activity. Mathematics education, for example, offers specific opportunities for co-operative learning with this purpose in view. To put it differently and to make the general idea more specific, the content of mathematics allows for specific models of co-operative learning to accommodate individual differences between students (Freudenthal 1991; Keitel 1987). Mathematical problems can be situated in real-life contexts and designed in such a way that solutions can be reached along different routes and at different levels. This makes co-operative learning in mathematics different from co-operative learning in other domains, such as languages and world orientation. The latter domains have their own opportunities that the teaching and learning process may offer. I will return to the specific opportunities of mathematics later in the context of our empirical research on co-operative learning in mathematics.

### Organization

Organization of purpose and content may be summed up in the following composite question: Should all students pursue the same purposes and content or should different programmes be offered to different categories of students? My position has always been that a common curriculum should be offered to all. The question is: How can this be realized in the classroom? Could co-operative learning offer a solution?

My interest in co-operative learning arose especially in the context of these questions. As a teacher in the lowest streams of the traditional Dutch secondary school system I became more and more aware of the limited opportunities for my students in the context of tracking, in which low achievers were separated from their more able peers. This was the result of a classical dilemma in the first stage of secondary education that can be stated as follows: Should we offer a common curriculum to all students between the ages of 12 and 15, or should we present different curricula to different categories of students (Walker 1990)? As is well known, this question has been the subject of intense debate and ongoing research in curriculum studies (Gravemeijer and Terwel 2000; Keitel 1987; Kliebard 1992; Oakes *et al.* 1992; Page 2000). The intensity and emotionality of the debate can be explained partly by the political, cultural and moral implications of the various viewpoints.

By stating the central question in these terms and by placing co-operative learning in the context of curriculum thinking and practice, we have arrived at the heart of one of the above-mentioned dilemmas, which has been described in curriculum literature under the heading of curriculum differentiation versus a common curriculum. Curriculum differentiation – offering different curricula to different categories of students – is common practice in all modern countries. However, for many researchers and scholars co-operative learning entails the promise of avoiding early selection and curriculum differentiation (streaming, tracking) and of promoting learning and social development in a common curriculum for all (Oakes *et al.* 1992). Can co-operative learning offer a way out of the to track or not to track dilemma?

### Curriculum differentiation: research into learning outcomes

Why is it so important to look for alternatives to curriculum differentiation? What do we know from research into curriculum differentiation and, more specifically, group composition (Driessen 2002; Guldmond and Meijnen 2000; Hallinan 1987; Hallinan and Kubitscheck 1999; Kerckhof and Glennie 1999; Orfield and Yun 1999; Pallas 1999; Reay 1998; Resh 1999; Terwel *et al.* 2001; Van den Eeden and Terwel 1994;

Webb 1982; Westerbeek 1999; Willms 1985; Yates 1966; Yonezawa *et al.* 2002)?

The research literature that covers more than a century may be summarized as follows. In contrast to the views of many policy-makers, as well as administrators and practitioners, curriculum differentiation has no effect on overall (average) learning scores. Students in streamed or tracked schools do not outperform their counterparts in integrated (non-streamed) schools. However, several studies show differential effects for high- and low-achieving students. High-achieving students tend to achieve better results in a system with tracking, while low-achieving students perform better in heterogeneous classes. One of the causal mechanisms behind these research outcomes may be found in classroom interaction processes, to which I will return below. In addition, there are indications that low-achieving students are more sensitive to the quality of their learning environment than high-achieving students, probably because the latter can rely more on personal resources such as prior knowledge, experience, cultural background and habitus. Dar and Resh (1986, 1994) indicated that curriculum differentiation turns out to be especially detrimental in the case of low achievers since they appear to lose more than the high achievers win, compared to a common curriculum for all. Although all students benefit from high-quality learning environments, there are indications that learners need to possess a certain minimum level to be able to profit from an enriched learning environment. To put it differently, there seems to be a limit to the performance interval around the mean in which students can benefit from richer learning environments. Note that generalizations on this point cannot be made, because the interval depends on the instructional models under consideration.

It is precisely at this point that co-operative learning enters the discussion. Many studies on co-operative learning do not specify the conditions in terms of group composition and instructional models as part of the curriculum. Many studies lack information about the interaction processes and the curricular content which may have produced the learning outcomes. I will therefore present the outcomes of a series of projects in which I was involved in the previous decades and in which we tried explicitly to address these points.

### Theoretical starting point: mathematics as a human activity

Our empirical studies into co-operative learning were, to a certain extent, inspired by the work of Hans Freudenthal, the well-known Dutch mathematician (Freudenthal 1973a, 1973b, 1980, 1991). Freudenthal, in turn, was influenced by Dewey, Piaget, Vygotsky, and the European progressivists Ovide Decroly and Peter Petersen. Freudenthal's wife, Suus Freudenthal

Lutter, was one of the pioneers who introduced Peter Petersen's Jenaplan School to the Netherlands. The Jenaplan School is well known for its use of various forms of co-operative learning as an integrated part of a curriculum for comprehensive education.

Fortunately, as a well-known mathematician and director of an institute for curriculum research and development and inservice training in mathematics (named the Freudenthal Institute), Freudenthal was able to go beyond his considerable sources of inspiration by making his philosophy more mathematical and therefore more useful to curriculum thinking and classroom practice. Freudenthal was one of the early proponents of co-operative learning in mathematics education. His co-operative learning model consisted of a combination of whole class instruction and working in small heterogeneous groups of four students. What was it that made his proposal for co-operative learning so attractive? It was the particular co-operative learning concept in which he explicitly addressed the fundamental curricular questions starting with Why, How, What and to Whom that inspired so many scholars, researchers and teachers.

My first encounter with Freudenthal took place in the 1970s, when I attended a conference on comprehensive education in the Netherlands (Freudenthal 1973a; Terwel 1990). In his lecture, Freudenthal criticized the German experiments with the middle schools, in which curriculum differentiation by means of tracking, streaming and setting was daily practice. 'Our German colleagues,' he said, 'differentiate students before they integrate them. This differentiation is merely an euphemism for separation' (Freudenthal 1973a). Freudenthal was strongly opposed to early selection and separation of students into different curricular programmes and proposed a new, integrated and common curriculum for all students in the first stage of secondary education. Freudenthal's educational credo was that mathematics should be learned as a human activity and that this could be realized by guided reinvention in co-operative groups of four. Freudenthal strongly advocated mathematics for all. He condemned all forms of streaming and setting by referring to the inevitable Matthew effects. He was convinced that students from different ability levels in the first years of secondary education should not only be in the same classrooms, but should also follow a common curriculum. In this newly designed curriculum students should work together in small heterogeneous groups. Thus Freudenthal's model of co-operative learning was an integrated part of his philosophy of education (Freudenthal 1973a, 1980, 1991; Gravemeijer and Terwel 2000).

Our research projects are based on principles of mathematics teaching and elements from cognitive theories and theories of motivation (Freudenthal 1973a, 1973b; Hoek *et al.* 1999; Terwel *et al.* 1994). Since working in small groups is of particular importance in the models under investigation, I will describe below the theoretical background. Samples of

the curriculum materials and protocols of interaction processes are given in Terwel (1990) and Hoek *et al.* (1997). In line with theories of cognition it is to be expected that working in groups accelerates the learning process. The dynamics behind the effects of group work may be found in the following five factors inherent in this type of learning environment:

- 1 Students in small groups are confronted by their fellow students in the group with different solutions and points of view. This may lead to sociocognitive conflicts that are accompanied by feelings of uncertainty. This may cause a willingness in students to reconsider their own solutions from a different perspective. The resulting processes stimulate higher cognitive skills. In principle, students can also conquer the uncertainty caused by different points of view with the help of other members of the group, particularly where difficult or complicated assignments are concerned.
- 2 Small groups offer group members the opportunity to profit from the knowledge that is available in the group as a whole. This may take the form of knowledge, skills and experiences that not every member of the group possesses. Students use each other as resources under those circumstances (resource-sharing).
- 3 Collaboration in small groups also means that students are given the opportunity to verbalize their thoughts. Such verbalizations facilitate understanding through cognitive reorganization on the principle that those who teach learn the most. Offering and receiving explanations enhances the learning process. Group members not only profit from the knowledge and insights transmitted through peer tutoring, but they can also internalize effective problem-solving strategies by participating in the collective solution procedures.
- 4 Positive effects of group work can also be expected on the basis of motivation theory. Co-operation intensifies the learning process. Students in the 12 to 16 age group are strongly oriented towards the peer group and very interested in interaction with their fellow students.
- 5 From the point of view of teaching methods in mathematics positive effects may be expected from the kinds of assignment that are used in groups. Varied assignments, which appeal to different levels of cognition and experiences, offer students the possibility of applying their strengths in the search for solutions.

### Developing a longitudinal multi-level model

Our empirical research into co-operative learning was conducted in a series of studies in the Netherlands and Australia (Brekelmans *et al.* 1997; Hoek *et al.* 2000; Terwel and Mooij 1995; Terwel *et al.* 2001). All studies were field experiments with a pretest-post-test control group design

with numbers ranging from about 440 to 810 students in 18 to 33 classes respectively.

In several studies it was found that class composition as measured, for example, by mean class ability in mathematics, has an effect on the development (transformation) of a student's initial knowledge towards his learning outcomes (so-called peer effects). Thus there were once more firm indications that the intellectual resources in a class can facilitate or hinder the learning processes and outcomes of students over and above the effects already explained by initial differences between students (Brekelmans *et al.* 1997; Terwel and Mooij 1995; Terwel *et al.* 2001).

In order to determine the effects of co-operative learning as a learning strategy and at the same time to account for differences in class composition a complex multi-level model was developed. The basic idea behind this model is that students do not learn in a compositional vacuum but are members of a heterogeneous class or small group. It follows that individual learning processes are influenced by the characteristics of the entities at higher levels; that is, the small group and the class. To illustrate these complex relations, we developed a theoretical model (see Figure 4.1). In this model, co-operative learning processes (interaction processes) must to be seen as the primary engines of learning and development. The quality of the interaction processes depends to a certain extent on the available cognitive resources in the classroom and the small group. To put it differently, the individual transformation process from pre-knowledge to learning outcomes is influenced by co-operative group work (interaction processes or experiences). These co-operative activities, in turn, are influenced by students' characteristics and curriculum differentiation

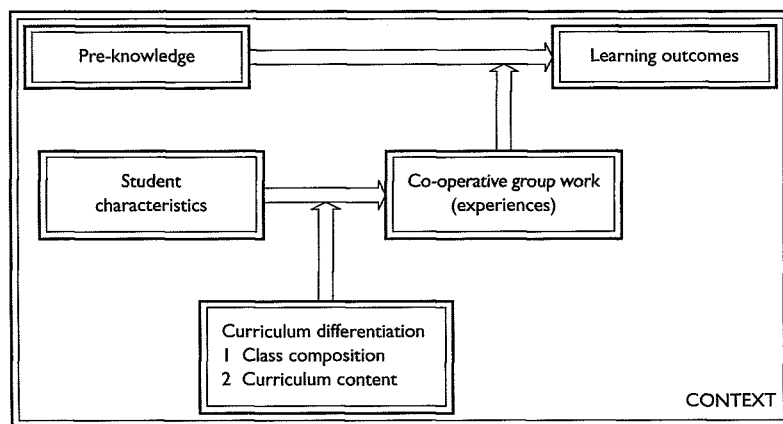


Figure 4.1 Co-operative learning: a longitudinal multi-level model

(consisting of the two main components class composition and curriculum). These processes and structures have to be placed in the context of the school as an institution that is embedded in the broader context of society.

From this model it follows that, in a curricular perspective, the outcomes of co-operative learning are not simply the sum of individual characteristics and social factors. Both factors play an important role in their contribution to the effects of co-operative learning, but always in connection with the purpose, content and organizational context of the curriculum.

### Outcomes of co-operative learning: empirical research

#### First co-operative learning experiment: the ID Project

In an extensive curriculum experiment of the National Institute for Curriculum Development (SLO), Freudenthal's ideas were put to the test by the development, implementation and evaluation of a mathematics curriculum for Dutch secondary schools (Terwel *et al.* 1988). The evaluation research was conducted by a team of researchers at the University of Utrecht in what was called the ID 12-16 project ( $N=763$ ). It was in this project that one of the major dilemmas of curriculum differentiation and co-operative learning emerged before our very eyes: Students in the experimental, co-operative learning groups outperformed students in the control group (effect size = 0.22); however, low-achieving students profited less from co-operative learning than high-achieving students (Terwel 1990; Van den Eeden and Terwel 1994).

The outcomes of two of the participating schools in the experimental condition were particularly instructive. The two high-quality schools involved in the research were comparable in terms of student population, teachers, initial mathematics scores, resources and curriculum. Both schools implemented Freudenthal's ideas on co-operative learning in groups of four, working on the same mathematical content but with the possibility of following different paths in the process of problem-solving which Freudenthal referred to as levels in the learning process.

The conditions under which the experimental curriculum was implemented differed on one salient point: whereas the one school, called The Yssel, implemented the Freudenthal curriculum in full as a common, co-operative learning curriculum for all in heterogeneous classrooms, the other school, called The Linge, implemented the same curriculum but in an existing system of separate streams for high-, medium- and low-achieving students. This offered a unique opportunity to test the effects of co-operative learning under two different models for organizing student populations in a real school setting. The results were in line with many

other international studies on streaming or tracking. Both schools were comparable in mean results. Thus there was a zero overall effect of streaming as compared to unstreamed classes. However, the experiment produced an intriguing trend: low-achieving students appeared to be better off in the heterogeneous classes at The Yssel, while high-achieving students did a better job at The Linge. This first experiment was the forerunner of a series of co-operative learning studies in which we also looked for the (differential) effects of class composition on co-operative learning processes and learning outcomes of high- and low-achieving students.

### Second co-operative learning experiment: the AGO Project

The experiences and empirical results of the Freudenthal model led to the development of a more elaborate instructional model, the AGO model, which combined whole class instruction, learning in small co-operative groups and individual work. This is a whole class model that allows for student diversity through *ad hoc* remediation and enrichment within small groups on a daily basis. The AGO model consists of the following stages.

- 1 Whole class introduction of a mathematics topic in real-life contexts.
- 2 Small group co-operation in heterogeneous groups of four students.
- 3 Teacher assessments: diagnostic test and observations.
- 4 Alternative learning paths depending on assessments consisting of two different modes of activity: (a) individual work at individual pace and level (enrichment), in heterogeneous groups with the possibility of consulting other students, or (b) opportunity to work in a remedial group (scaffolding) under direct guidance and supervision of the teacher.
- 5 Individual work at own level in heterogeneous groups with possibilities for students to help each other.
- 6 Whole class reflection and evaluation of the topic.
- 7 Final test.

The model provides for diagnostic procedures and special instruction and guidance by the teacher in a small remedial group for low-achieving students.

This cycle is extended through a series of lessons (units) over, for example, three to five weeks, preferably in extended units of uninterrupted instructional time. Each cycle begins with whole class instruction; for example, in the form of a systematic explanation or a Socratic dialogue. The aim of the instruction is to provide an overview of the learning unit and to introduce the most important concepts and solution procedures. The teacher is free to incorporate whole class instruction during other components in the cycle.

After the whole class instruction students work in small, heterogeneous groups of four. The assignments are designed specifically for group work. It is characteristic of AGO that group assignments (where possible or desirable) are presented in real-life contexts. The concepts and solution procedures necessary for the programme's problems are explicitly taught (i.e. in the classroom) before the students start their assignments. The assignments are constructed in such a way that collective solutions in, say, groups of four make sense. Problems can be solved in different ways (depending on levels in the learning process). In view of the support that is devoted to the solution process in the learning materials, as well as the supervision that the class or group receives from the teacher, the group process may be described as guided co-construction. In a whole class intermezzo students report on the solutions they have arrived at in the groups and reflect, under the guidance of a teacher, on the differences in solutions and methods of solution.

There then follows a diagnostic test for each individual student. This test may be more or less open depending on the aims of the relevant cycle. It is a means of verifying the level that each student has attained. The teacher marks or grades the test and discusses the results in class. He or she decides – on the basis of the results and his or her personal experiences with the students – how to continue (i.e. whether there should be multiple learning tracks for weaker and stronger students). Students who fall behind, and whose knowledge clearly shows gaps, receive specially adapted instruction from the teacher in groups of, for example, four to six. Other students work independently on individual assignments. Conferring is allowed.

In the next stage, students work independently on assignments in the same heterogeneous groups as for the co-operation component, but the method of working differs in that students work independently on different assignments. Students are again allowed to ask each other for assistance. The teacher supervises individual students. Finally, the teacher ends the classroom cycle. Again, students are allowed to report. The teacher winds up the cycle with a recapitulation of the most important concepts and solution procedures.

In the research project the AGO cycles finished with a final test. This is a research test, but it is also used by the teacher as a means of determining class test marks. The teacher discusses the results after the final test and subsequently introduces a new learning unit.

In this second experiment, the AGO model was put to the test. Students in the experimental (AGO) condition outperformed their counterparts in the control group ( $N = 582$ ). In this project an effect size of 0.68 was found. In addition, a significant effect of class composition was found. Students in classes with a higher mean ability outperformed their counterparts in classes with a lower mean after controlling for initial individual

differences in mathematical ability. Also in this project, indications were found that low-achieving students profited less from learning in small groups than high-achieving students (Terwel *et al.* 1994).

### **Third study: distance to the mean**

Inspired by the outcomes of the two earlier projects, a secondary analysis was conducted on the data of the experimental classes in both the ID 12-16 project and the AGO project. This time the main focus was on the relative position of students in their classes. Lower and higher achieving students were defined in relation to their own class mean by using the variable called distance to the classroom mean. In fact, we were looking for the effect of the relative starting position of a student in his class. The outcomes of the analyses were identical in both projects. Students with a pretest score below the mean of their class gained by being in a relative good class and vice versa. This effect of the relative position of a student was over and above the effect of the pretest. To conclude, the classroom makes a difference in co-operative learning. These outcomes were especially convincing because the same effects of distance to the mean were found in both projects. The findings may contribute not only to theory and practice of co-operative learning but also to the frog pond theory. Our answer to the question 'Is it better to be a big frog in a small pond than a small frog in a big pond?' clearly favours the latter (Terwel and Van den Eeden 1994).

### **Fourth project: training students for problem-solving in co-operative groups**

After having determined the positive overall effects of co-operative learning and the effects of the classroom we directed our focus towards the prerequisites of co-operative learning. What kind of pre-knowledge and strategies do students need in order to successfully participate in group-work? In a third project a modification of the AGO model was used (Hoek *et al.* 1997). Students were trained in social or cognitive strategies for realistic problem-solving contexts in co-operative groups (with  $N = 144$  and  $172$  respectively and  $N = 195$  for the control group). Special attention was given to the analysis of differential effects for high- and low-achieving students. The outcomes show the expected positive effects (effect sizes  $0.32$  and  $0.52$  for, respectively, the social strategies programme and the cognitive strategies programme as compared to a control group). In addition to this main effect, the low-achieving students in the experimental condition outperformed their counterparts in the control group, indicating that the special training and remedial instruction of low-achieving students had a compensating effect. This was the first time we were able to show that low-achieving students benefited from co-operative learning!

### **Fifth experiment: combining training in social and cognitive strategies**

The aim of the fifth study was to assess the effects of the social and cognitive training as combined in one programme ( $N = 222$  for the experimental group and  $N = 222$  for the control group). It was hypothesized that integration of programmes would be more powerful than the separate social or cognitive programme in the third study (Hoek *et al.* 1999). The outcomes showed an overall effect of the experimental programme ( $ES = 0.21$ ). It turned out that combining the two strategies benefited the high achievers rather than the low achievers. This last outcome was not expected but, with hindsight, seems reasonable in view of the high cognitive demands made by the integrated programme. Low achievers in particular seem to profit from strategy training as long as the instruction is not too complex and as long as the student composition of the small group allows for a rich learning environment, in which high-achieving students can serve as role models.

### **Conclusions and discussion**

The overall conclusion from these co-operative learning experiments is that, in comparison with the control programmes, the experimental programmes produced positive outcomes. In all experiments, students in the co-operative learning programme outperformed their counterparts in the control condition. In some of the experiments differential effects for high- and low-achieving students were found. This warrants the conclusion that special attention to low achievers is necessary. Training in the use of social and cognitive strategies would seem to be an attractive avenue for further development and research, particularly in the area of support for low-achieving students. In addition, from the multi-level analyses, clear indications were found that the student composition of the small group and the class promotes or hinders learning processes and outcomes. These positive experiences and outcomes of co-operative learning are in line with other studies (e.g. Cohen 1994; Cohen and Lotan 1995; Webb and Farivar 1994).

More specifically, the outcomes regarding the effects of group and class composition are not only in line with the work of Dar and Resh (1986, 1994) but also with other recent studies in The Netherlands, in which cognitive and sociocultural differences in classroom composition were also taken into consideration. These effects can, to a large extent, also be explained by differences not so much in the colour of a classroom (black or white) as in its cognitive resources. Such resources can, in turn, be traced back to the categorically differentiated experiences of the students in their socio-economic home backgrounds and in their local communities (Driessen 2002; Tilly 1998; Westerbeek 1999).



The findings revealed what many parents already know intuitively: student composition counts, whether in a school, a class or a small group. Students in classes with a higher mean ability tend to give each other higher quality help and feedback than do their counterparts in lower classrooms (Terwel *et al.* 2001). Not only teachers, but fellow students as well, can really make a difference. These findings are a challenge to curriculum theorists, and especially to scholars and teachers involved in discussions about co-operative learning. Furthermore, the study of co-operative learning strategies can contribute to the to track or not to track debate in the first stage of secondary education. However, co-operative learning is not a panacea and we need to be aware that, just because of its flexibility, it can be applied in ways and in classroom contexts that might be detrimental, especially to the interests of low-achieving students. In our research projects the focus became more and more on the prerequisites of co-operative learning and on the group composition. What kinds of pre-knowledge and strategies do students need in order to participate successfully in group work? And since we know that students in co-operative learning depend on their fellow students, what kind of group composition is necessary to evoke high-quality interaction processes? To profit from co-operative learning low-achieving students, in particular, need to be prepared and guided over an extended period of time in the use of social and cognitive strategies in heterogeneous classrooms.

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